



## **NASA STTR 2005 Phase I Solicitation**

### **T8 Marshall Space Flight Center**

Continued technological innovation is critical to a strong manufacturing sector in the United States economy. The Federal Government has an important role in helping to advance innovation including innovation in manufacturing, through small businesses. The President issued an executive order directing Agencies, to the extent permitted by law and in a manner consistent with the mission of the Agency, to give high priority within such programs to manufacturing-related research and development. NASA is interested in innovative manufacturing technologies that enable sustained and affordable human and robotic exploration of the Moon, Mars, and solar system. The nation's ability to decrease the cost and schedule required to develop new space transportation systems that are required to support NASA's exploration missions is hampered by inadequacies in our design tools and databases. Space transportation systems operate at the extremes of our materials capabilities, therefore any shortcomings in our ability to predict the internal operating environments during the design process will almost always lead to redesigns during the development of the system. These redesigns are costly and always compromise the project's schedule. One way to address this issue is to increase the fidelity and accuracy of the tools used to predict the internal operating environments during design.

## **Subtopics**

### **T8.01 Aerospace Manufacturing Technology**

**Lead Center: MSFC**

Continued technological innovation is critical to a strong manufacturing sector in the United States economy. NASA is interested in innovated manufacturing technologies that enable sustained and affordable human and robotic exploration of the Moon, Mars, and solar system. Specific areas of interest in this solicitation include innovative manufacturing, materials, and processes relevant to propulsion systems and airframe structures for next-generation launch vehicles, crew exploration vehicles, lunar orbiters and landers, and supporting space systems. Improvements are sought for increasing safety and reliability and reducing cost and weight of systems and components. Only processes that are environmentally friendly and worker-health oriented will be considered.

Proposals are sought, but are not limited to, the following areas:

#### **Polymer Matrix Composites (PMCs)**

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Large-scale manufacturing; innovative automated processes (e.g., fiber placement); advanced non-autoclave curing (e.g., e-beam, ultrasonic); damage tolerant and repairable structures; advanced materials and manufacturing processes for both cryogenic and high-temperature applications; and improved thermal protection systems (e.g., integrated structures, integral cryogenic tanks and insulations).

### **Ceramic Matrix Composite (CMCs)**

Materials and processes that are projected to significantly increase safety and reduce costs simultaneously while decreasing weight for space transportation propulsion. Innovative material and process technology advancements that are required to enable long-life, reliable, and environmentally-durable materials.

### **Metals and Metal Matrix Composites (MMCs)**

Advanced manufacturing processes such as pressure infiltration casting (for MMCs); laser engineered near-net shaping; electron-beam physical vapor deposition; *in situ* MMC formation; solid state and friction stir welding, which target aluminum alloys, especially those applicable to high-performance aluminum-lithium alloys and aluminum metal-matrix composites; advanced materials such as metallic matrix alloys compositions, which optimize high ductility and good joinability; functionally graded materials for high- or low-temperature application; alloys and nanophase materials to achieve more than 120 ksi tensile strength at room temperature and 60 ksi at elevated temperature above 500° F; new advanced superalloys that resist hydrogen embrittlement and are compatible with high-pressure oxygen; innovative thermal-spray or cold-spray coating processes that substantially improve material properties, combine dissimilar materials, application of dense deposits of refractory metals and metal carbides, and coating on nonmetallic composite materials.

### **Manufacturing Nanotechnology**

Innovations that use nanotechnology processes to achieve highly reliable or low-cost manufacturing of high-quality materials for engineered structures.

## **T8.02 Advanced High Fidelity Design and Analysis Tools For Space Propulsion**

**Lead Center: MSFC**

The pace at which the United States, through NASA, explores space will largely be driven by the cost of developing the systems required to make future explorations practical. The nation's ability to decrease the cost and schedule required to develop new space transportation systems that are required to support NASA's exploration missions is hampered by inadequacies in our design tools and databases. Space Transportation systems operate at the extremes of our materials capabilities, therefore, any shortcomings in our ability to predict the internal operating environments during the design process will almost always lead to redesigns during the development of the system. These redesigns are costly and always compromise the project's schedule. One way to address this issue is to increase the fidelity and accuracy of the tools used to predict the internal operating environments during design.

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Universities are at the leading edge of development of new, "first principles" physical models of development of new high-fidelity numerical approaches for simulating operation of space transportation systems and of developing experimental approaches and data required to validate these tools. Transition of these technologies, however, from an academic setting to a production, applications-centered environment, where it can be applied to the design of NASA's space transportation systems, requires focused effort. Efficient and timely transfer of these capabilities from the university setting to the operational (production) setting is required to reduce the developmental risks associated with NASA's space transportation systems and to maximize the return on NASA's investments at the nation's colleges and universities.

This subtopic solicits partnerships between academic institutions and small businesses for the purpose of developing novel design and analysis approaches and the methods by which to validate them into useful production tools that can be used to develop NASA's space transportation systems. Examples of specific areas where innovations are sought follow:

- Efficient, three-dimensional (3D), time-accurate analysis tools for modern rocket engine combustion chamber and turbomachinery environments and performance;
- Efficient, three-dimensional (3D), time-accurate analysis tools for predicting the environment and loads internal to valves, lines, and ducts in modern rocket engines;
- Practical 3D, steady and time-accurate, multidisciplinary analysis (MDA) tools for design of space transportation systems components and subsystems;
- Practical approaches for predicting the time-varying, 3D flow field in cases involving relative motion between objects;
- Practical Large Eddy Simulation (LES) tools for the analysis of high pressure reacting flows;
- Automated hybrid grid generation tools and grid adaptation tools;
- Efficient and accurate fluid properties routines for the range of conditions applicable to rocket engines;
- Automated approaches for extracting key engineering information and flow features from 3D flow simulations;
- Automated approaches for validating and assuring quality of application software;
- Practical, unsteady, 3D cavitation models for implementation into Reynolds-Averaged Navier-Stokes (RANS) analysis codes;
- Advanced instrumentation and diagnostic techniques necessary for acquisition of steady and unsteady code validation data; and
- Validation data for all of the tool types mentioned above.

